Abstract

Creating high-quality illustrations presents a significant challenge for beginners, primarily due to the high demands for stylistic complexity, fine-grained detail, and proportional accuracy inherent in artistic creation. Traditional drawing assistance systems, such as retrieval-based approaches, typically rely on pre-constructed databases, lack flexibility, and struggle to effectively accommodate diverse user inputs. In this context, this study proposes an efficient interactive drawing assistance system capable of generating multiple guidance sketches in real time to support user drawing. The system also allows users to select from various drawing styles, including anime, realistic, and others, based on their preferences. It not only lowers the creative threshold for beginners, helping them complete their illustrations more smoothly, but also provides rapid and high-quality support for users with basic drawing skills, thereby improving overall drawing efficiency and creative freedom.

The system is built upon the StreamDiffusion inference framework, an optimized diffusion-based architecture capable of generating high-quality RGB images in real time. To meet the demands of various artistic styles, the system adopts Low-Rank Adaptation to efficiently fine-tune the Stable Diffusion model, achieving rapid style adaptation with only a small number of style-specific samples. The system supports multimodal input, allowing users to simultaneously provide hand-drawn sketches and textual prompts, thus enabling the generation of RGB images consistent with the selected style. These generated images are subsequently processed by the Informative Drawings model, which extracts structural features by integrating geometric and semantic information, producing rough sketches. To further enhance the effectiveness of the sketches as drawing guidance, a custom-designed denoising optimizer is implemented, which employs image filtering techniques to remove unnecessary noise while preserving essential edge structures, ultimately producing clean and structurally coherent guidance sketches.

To systematically evaluate the usability and effectiveness of the proposed system, a user study was conducted involving participants with varying levels of drawing experience. The experiment compared three types of drawing interfaces: (1) a baseline interface without any assistance, (2) a shadow-guidance interface with a reference sketch fixed beneath the canvas, and (3) the proposed drawing assistance interface. The usability of the proposed interface was quantitatively assessed using the System Usability Scale (SUS), and user preferences were collected to statistically analyze how effectively each interface supported users in achieving their intended drawings.

To further verify the system's effectiveness during the actual drawing process, expert and non-expert reviewers were invited to evaluate the users' drawings. Evaluation criteria included overall shape accuracy, local proportion consistency, and line clarity and expressiveness. Experimental results demonstrate that the proposed system significantly improves drawing quality. The SUS scores also reflect users' high satisfaction with the system's ease of use and overall experience. Preference analysis further indicates that, compared to other interfaces, the proposed system enables users to produce drawings that better align with their original creative intentions, highlighting its effectiveness in supporting personalized artistic expression.

In summary, this study presents a real-time drawing assistance system that integrates the StreamDiffusion image generation framework, LoRA fine-tuning, a structural sketch extraction model, and a filter-based denoising optimization module. The system provides efficient and accurate drawing guidance across a range of artistic styles, significantly enhancing users' drawing efficiency and creative experience, and demonstrating strong potential for practical application and broader adoption.